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The role of environmental framing in socio-political acceptance of smart grid: The case of British Columbia, Canada

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ABSTRACT

Various "smart grid" technologies can help achieve a region's environmental and climate mitigation goals by facilitating the deployment of renewable energy sources, transportation electrification, energy conservation and load-shifting of electricity use. This study reviews and explores the role of environmental framing in the socio-political acceptance of smart grid technologies by citizens, media, and key stakeholders, using the case study of British Columbia, Canada—a low carbon electricity-based region where smart grid deployment has been mandated as part of climate change legislation. We collected and analyzed data from British Columbia via a survey of Canadian citizens implemented in 2013 (n = 2930), a media analysis of newspaper articles from 2007 to 2012, and interviews with key stakeholders in 2013. We find that overall citizen acceptance of one smart grid technology (smart meters) is relatively low in British Columbia, but acceptance doubles when the survey explicitly describes smart meters according to positive frames, namely environmental benefits without installation costs or mandatory enrolment. In contrast, we find that media and key stakeholders in British Columbia focus more on economic frames of smart grid deployment (e.g. reducing electricity costs) than environmental frames (e.g. climate abatement). Further, we find that news media mention smart grid risks 50% more frequently than benefits. By comparing these different aspects of socio-political acceptance, we suggest that key stakeholders seeking to deploy smart grid technology could better stimulate citizen support in certain jurisdictions by more actively using positive, pro-environmental frames and by better engaging with citizens earlier in the technology and policy design and deployment process.

1. Introduction

1.1. Review of smart grid technology and climate change mitigation

Many jurisdictions are examining electricity system change as a means to address climate change. Various "smart grid" initiatives can help achieve a region's climate reduction goals including deployment of smart meters, real-time consumer feedback, time-of-use pricing, feed-in tariffs for renewables, and vehicle-grid-integration (VGI or V2G) [1]. Table 1 provides examples of how some of these components can help decrease a region's greenhouse gas (GHG) emissions by inducing electricity conservation or load-shifting of electricity use, facilitating the integration of intermittent renewable sources of energy such as wind or solar, and supporting the electrification of other sectors that predominantly rely on fossil fuels, such as transportation and heating. Further, smart grid has the potential to mitigate GHG emissions in regions regardless of their present electricity grid mix—e.g., helping fossil fuel-based regions transition to renewable energy sources and helping hydro-electricity-based regions to electrify other sectors.

In addition to climate motivations, a region may choose to deploy smart grid as a tool to reduce costs or to improve grid reliability [1–3]. Given these competing goals, it may be important for policy makers to recognize and articulate the motives behind smart grid deployment—if climate mitigation is not prioritized, smart grid may develop in a way that has little effect, or even a negative effect, on a region's GHG emissions [4]. For instance, efforts to reduce the cost of electricity generation through smart grid integration may increase usage of fossil fuels rather than renewable energy sources because in the absence of strong carbon pricing, intermittent wind and solar are typically more expensive per kWh [1]. Of course, in some situations financial motivations can be achieved concurrently with climate change mitigation, e.g. in-home displays can increase electricity conservation, which would lower both costs and GHG emissions [2,5]. However, given the potential for conflicting and/or unclear policy goals, a clear prioritization of these goals within jurisdictions will likely be helpful in guiding smart grid deployment.

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Table 1
Review of key smart grid components and their potential role in climate change mitigation.

Component	Description	Role in reducing GHGs
Smart meter	A bidirectional electricity meter that provides utilities with remote, real time access to each customer's electricity use	Smart meters can indirectly abate GHGs by providing the bidirectional communication necessary for initiatives such as dynamic pricing, consumer displays, and vehicle-to-grid integration [3,6]
Consumer information and feedback systems	An interface that provides customers with instantaneous electricity usage information and decision support tools	Feedback systems can help consumers conserve electricity and shift demand to accommodate intermittent renewable energy sources [4,7]
Dynamic pricing, e.g. time-of-use pricing	Smart meters allow utilities to set rates according to time value of electricity (e.g. time-of-use pricing implements a higher rate during peak demand periods)	Dynamic pricing can shift demand to correlate with intermittent renewable energy sources, and reduce need for new capacity [1]
Autonomous Smart appliances	Smart appliances can communicate directly with utilities and activate according to demand and supply	Smart appliances can reduce the need for new capacity and shift demand to correlate with intermittent renewable energy generation [8]
Vehicle-grid-integration (VGI) or V2G	VGI or V2G can allow electric vehicle owners to charge at a reduced rate during low demand periods and sell electricity to the grid during peak demand periods	VGI or V2G can help shift charging patterns and reduce potential capacity problems caused by electric vehicles entering the market [9]
Feed-in tariff	Utilities can offer electricity rate incentives to consumers that produce a certain type of electricity	Feed-in tariffs can incentivize renewable energy generation by reducing the risk of investment [10]
Remote monitoring of Utility assets	Smart sensors can remotely monitor and adjust transmission and distribution assets	Smart sensors can facilitate faster switching between intermittent renewables and base load generators [1]

In this paper we explore socio-political acceptance of smart grid; in particular how the framing of smart grid environmental benefits may be associated with the acceptance of smart grid technologies by citizens, media, and key stakeholders (three components of socio-political acceptance). We use British Columbia, Canada as a case study, where their rollout of smart meters—one visible component of smart grid—met with considerable resistance [11]. We next provide a literature review on socio-political acceptance and framing, and then summarize our conceptual framework.

1.2. Literature review: socio-political acceptance and framing of energy projects

Social acceptance is one important dimension to consider in the deployment of smart grid technologies—particularly those technologies that the public interacts with on a regular basis [12]. According to Wustenhagen et al. [13] social acceptance is composed of three categories: community, market, and socio-political acceptance. In this paper we focus on socio-political acceptance, which is defined as general acceptance by citizens (or the public), which in turn can be guided by and represented through news media, and key stakeholders [13,14]. We consider research on these three components of socio-political acceptance of energy in general before turning to our specific focus on framing. First, citizens play an important role as voters of governments that implement policy, as potential consumers of the energy produced, and as sub-groups of opposition (or support) that may take social action [13]. Citizen support for an energy project can be influenced by their beliefs and perceptions regarding the project and its risks and benefits [15,16], which may in turn be shaped by the individual's core values or worldview [17–19]. Literature has tended to focus on cases of citizen support and/or opposition in the cases of renewable and nuclear power, e.g., [20], with only a few applications to smart grid, e.g., [21]. In general, research demonstrates that citizen support is influenced by beliefs [22], as well as trust in implementers and operators, political affiliation, proximity to the project site, and perceptions of fairness [17,18,20,23–25].

Second, media can play a critical role in socio-political acceptance of energy projects by framing public debate and shaping citizen support [14,26–28]. Analysis of news media is also useful in that it reflects societal discourse about energy deployment [29–31]. Media analyses finds that energy project stakeholders develop competing frames which accent (or omit) particular benefits, costs and risks of energy projects, such as economic growth, job creation, energy security and ecological impacts [21,32–35]. Media coverage of such frames has been associated with changes in socio-political support for a variety of projects and policies [14,36]. Despite the apparent importance of media, many dynamics are still unknown. On one hand, citizen exposure to multiple competing frames, both positive and negative, can effectively cancel out with little overall effect [37]. On the other hand, citizens might filter news sources and stories according to their values, thus reinforcing their values [38–40].

Third, key stakeholders make up the final components of socio-political acceptance. Governments, industry groups, environmental non-governmental organizations (NGOs) and others may try to act in the public interest and/or influence public opinion of energy projects [13,41–43], while some evidence suggests that government or proponent activities may stimulate opposition [44,45]. Key stakeholders can use storylines to offer distinctive and often competing interpretations of particular projects and events [46], which can shape the overall trajectory of state energy policy [47–49]. For instance, governments may try to focus on economic benefits to avoid a storyline of “clean” versus “dirty” energy [50], or to re-frame their energy source altogether, for example when the government of Alberta, Canada used the term “ethical oil” in an attempt to legitimize oil sands development [27,51]. These storylines or frames are important as they can influence how people internalize issues—for instance Baumgartner and Jones' [52] work on issue framing in the 1990s notes the evolution of nuclear power being associated with the storyline of economic progress to a power source causing environmental damages.

Here we focus on framing as one lens to view the socio-political acceptance of energy. Frames are a means through which people attempt to understand unfamiliar and complex concepts through their own experiences and predispositions [14]. A rich body of literature explores how the framing of technologies, policies, science, and social issues can influence citizens' perceptions and public decision-making processes [31,53]. With respect to energy technologies and climate change, frames can favour (or hinder) the deployment of certain energy technologies as well as the mechanisms (e.g. policies and programs) used in their deployment. For instance, research has linked how changes in framing have influenced the rise and wane of support for climate change and nuclear energy in the United States [14], GHG emissions trading schemes in the European Union [54], and bioenergy in Finland [36]. Stakeholders have been found to frame such energy projects according to a number of potential benefits and risks, notably environmental benefits, local energy security, economic impacts and job creation. While some research suggests that economic frames can most effectively resonate with the public [55], evidence indicates that citizens may also weigh criteria such as environmental considerations, personal values, social status, and social norms when assessing a technology [21,30]. Also, evidence suggests that more social-political acceptance of renewables could accrue by using frames that are aligned with locally relevant social values [56]. Furthermore, energy initiatives

can be reframed over time (intentionally or not). Such reframing can sometimes improve socio-political support, such as shifting from the "doom and gloom" climate change scenarios towards climate action as a means to spur economic development and innovation [14].

Framing appears to be important in the three components of socio-political acceptance that are summarized above. First, citizen perception and support for (or opposition to) an energy project can be particularly influenced by framing [21]. For example, citizen surveys in Denmark, Norway and Switzerland show that citizens are more likely to accept smart grid technologies when they are aware of both the environmental benefits (such as GHG abatement) and economic benefits (such as cost reduction) of smart grid [57]. Second, framing is also important when analyzing news media because news media both reflects and influences societal discourse about energy deployment, and can shape citizen and stakeholder perceptions regarding a novel concept such as smart grid [29,30]. For instance, one U.S. media analysis shows that newspapers are 3.7 times more likely to mention smart grid benefits than risks, which is thought to both reflect and reinforce the technological optimism expressed by citizens and stakeholders in the analyzed regions [30]. Finally, key energy stakeholders such as government, utilities, and industry often have pre-established motivations for an energy project linked to their perception of its risks and benefits and their affiliated organization's mandate [58]. These stakeholders can directly influence an energy project's design and implementation strategy and at the same time can influence how media and the general public perceive and frame energy issues [7,58]. In other words, through influencing socio-political acceptance of sustainable energy technologies, framing affects policy outcomes. This link between framing and policy outcomes can also be more direct, where research on smart meters in Denmark suggests that when citizens were presented with loss-framed information, demand reduced by 7–11% and standby electricity consumption reduced by 16–25%, as compared to when information was presented without frames [59].

1.3. Conceptual framework and research design

The above literature review summarizes different but interrelated aspects of socio-political acceptance of energy and smart grid; citizen perceptions can be influenced by media and stakeholders, while media and stakeholder storylines and frames can also reflect citizen interests and concerns. While these three literatures occasionally refer to each other, they are largely separate; individual studies tend to focus on only one or two components of socio-political acceptance [60]. The present study attempts to integrate insights across these literatures through analysis of framing in a multi-method approach. Specifically, we utilize the Socio-Political Evaluation of Energy Deployment (SPEED) framework. SPEED was created in recognition that energy deployment occurs within energy systems that are not only influenced by technological capacity and resource availability, but also by "institutional, legal, political, economic, and cultural factors" [33]. SPEED recognizes that subnational (e.g. provincial, state, or municipal) contexts vary considerably and that the majority of energy deployment in North America is occurring at the subnational level. Therefore, Langheim et al. [30] critique energy deployment strategies and research that narrowly focus on techno-economic issues (resource availability, infrastructure needs, and energy demand) and ignore the unique aspects of regional socio-political contexts.

The breadth of the SPEED framework can help researchers to position environmental frames within the larger socio-political context of a region—including citizen, media and stakeholder roles. Specifically, SPEED has been applied to energy deployment case studies through analysis of risks and benefits within six categories: technological, economic, political, cultural, health and safety, and environmental [30]. These categories are based on Luhmann's [34] theory of society, which suggests that society is composed of interactive, self-organizing subsystems; each subsystem has its own way of understanding the world. These SPEED categories can help researchers analyze policy documents, media content, stakeholder interviews, focus groups, public surveys, and other data to help assess how actors and institutions are responding to and/or shaping energy and policy deployment [33]. As examples, SPEED's environmental frame category includes climate change concerns, energy conservation, and reduced air and water pollution. The technical frame category includes infrastructure and reliability concerns and the economic category includes cost and employment forecasts. Further, the political frame category includes regulatory and election issues; the health and safety category includes technological externalities that impact human health; and the cultural category includes aspects salient to people's daily lives, such as whether or not these smart grid technologies are viewed by people as being invasive to their privacy or having little impact on their daily routines (e.g. a time delay option that turns on an appliance at off-peak electricity usage times).

We apply aspects of the SPEED framework to our research objectives using British Columbia, Canada as a case study. British Columbia legislated the deployment of smart grid technology as part of its 2010 Clean Energy Act, though subsequent deployment of smart meters was met with considerable public opposition [11]. While British Columbia's electricity context is less typical in many ways—e.g. being monopoly-controlled, and having abundant large hydro energy and strong climate policy—we believe that our exploration yields some general insights (and/or generates hypotheses) regarding smart grid framing that could apply to a variety of other regions globally. To explore how framing is impacting socio-political acceptance, we collected data from three sources that correspond with aspects of socio-political acceptance identified by Wustenhagen et al. [13]: a survey of citizen attitudes and support for smart meters (an example of smart grid technology), a media analysis of smart grid coverage in the region's two most widely-circulated newspapers, and interviews with key smart grid stakeholders in the region. Our specific research objectives are to:

1. Identify citizens' perceptions of smart meters (as a smart grid technology they were likely aware of), and the potential role of framing;
2. Characterize media framing of the risks and benefits of smart grid;
3. Characterize how key regional stakeholders envision and frame the risks and benefits of smart grid; and
4. Integrate findings from these three analyses to better understand the role of framing in socio-political acceptance of smart grid deployment.

The remainder of this paper is separated into six main parts. In Section 2, we provide an overview of smart grid deployment in the context of British Columbia. From there, Sections 3–5 each overview the method and results for three components of our methods: a citizen survey, a media analysis and stakeholder interviews, respectively. In Section 6, we discuss our findings in a general context and identify hypotheses for future research on socio-political acceptance of energy and smart grid. Finally, in Section 7, we offer a conclusion and policy implications.

2. Case study: smart grid in British Columbia's socio-political context

British Columbia is a Canadian province that has a unique energy context on several levels. During the period of study (and at the time of publication), the province plans to reduce economy-wide GHG emissions 33% below 2007 levels by 2020 and 80% by 2050. British Columbia Hydro (BC Hydro) holds a regulated monopoly on the transmission and distribution of electricity; in 2015, BC Hydro serviced over 1.9 million customers (over 90% of the Province's population). British Columbia's electricity is predominantly sourced from low-

emission, large-scale hydro-electricity (over 90%), and is sold at one of the lowest electricity rates in North America. In 2014, residential customers in British Columbia paid 7.5 cents/kWh CDN$ for the first 1350 kWh, whereas the Canadian and US averages were 11.9 cents/kWh CDN$ and 12.5 cents/kWh USD$ respectively [61,62].

Even though British Columbia's electricity grid is relatively low-emission, there are other significant sources of GHG emissions. In 2012, 71% of British Columbia's GHGs were attributed to transportation and stationary combustion, i.e. residential and commercial heating, which totalled 44,951 kilotonnes of CO_2e (approximately 10 t per BC resident). Further, the province's electricity demand is expected to increase by 40% over the next 20 years due to population growth and burgeoning natural gas development [63,64]. Therefore, if British Columbia is to meet its GHG abatement goals it remains important for the province to invest in multiple climate mitigation tools to facilitate the uptake of renewable energy, conservation measures and electric transportation—where various smart grid technologies may be required to facilitate such a transition.

British Columbia's provincial government has the primary authority to regulate electricity development [65,66]. The government legislated the Clean Energy Act in 2010, which aims to increase renewable energy deployment, energy conservation, and electrification of fossil fuel-based technologies. To help meet these objectives, the Clean Energy Act also mandated the Smart Meter Program. From 2010 to 2014 British Columbia installed 1.9 million smart meters across the province [67]. This program was exempted from a British Columbia Utilities Commission review—missing an early opportunity for public engagement. Citizens were notified of the smart meter rollout via a letter from BC Hydro informing them of a mandatory switch to the new meters. The Smart Meter Program experienced strong opposition from several groups of citizens, such as the "Citizens for Safe Technology", a group that was concerned about smart meter privacy and human health risks [11]. These negative frames accrued during the implementation process and seemed to play a particularly strong role in the region's dialogue on smart meter technology. In response to this opposition, BC Hydro strengthened its protection of smart meter data and offered an opt-out program at an extra cost ($32 CDN per month) for customers who wished to keep their old meters [68]. As of 2015, over 15,000 customers had chosen the opt-out option [67].

While this paper's focus is on British Columbia, we compare the survey results from BC citizens to those from two other Canadian provinces, Ontario and Alberta—here we provide some brief context for each. Ontario is an interesting comparison because it is considered the most developed Canadian province in terms of smart grid policy and implementation. Between 2007 and 2013, with major rollouts beginning in 2010, Ontario deployed 4.7 million smart meters coupled with time-of-use pricing and no opt-out policy for either. In contrast to BC's monopoly utility model, Ontario has 73 local electricity distribution companies each responsible for implementing smart grid initiatives [69]. Alberta is an interesting comparison because as of 2013, the province had yet to set clear smart grid policy or to implement a major smart grid initiative.

3. Component #1: citizen survey

3.1. Survey method

To assess citizen perceptions of smart meters, we collected data from Canadian citizens through a web-based survey administered between February and May of 2013. The survey instrument was primarily designed for a transportation-related research project, and the target population was new vehicle buying households in Canada—which is a subset of the full population of Canadian citizens. The sampling frame includes a wide distribution of citizens by various socio-demographic variables and values. The sample was invited at random from respondent panels maintained by two market research companies: Sentis Market Research and Survey Sampling International. Of the 12,978 respondents invited, 4590 met the demographic criteria of the screener and were accepted into the study. Of the 3643 that started the survey, 2835 completed it. A further 207 were removed due to low quality responses or duplicate responses from the same household. A total of 2560 useable responses were collected from these three provinces: British Columbia (n = 929), Alberta (n = 621) and Ontario (n = 1010). Further details of the full survey instrument are available online [70].

Respondents were screened to represent target population distributions of age, gender, income and education (as noted above, that target population was new vehicle buying households). Appendix A depicts the characteristics of the entire sample, as well as the British Columbia, Alberta and Ontario subsamples, each compared with Canadian census data. Respondents from all provinces are more slightly likely to be female than Census data, and more likely to have higher education levels. The Canada-wide and British Columbia samples are slightly younger on average than Census data. All samples have a lower proportion of lower-income households (earning less than $70k per year) than the Census data. These demographic differences are not severe, and are not expected to substantially impact the present exploration of citizen perceptions of smart meters. The sample is highly diverse on all scales relating to demographics, values, attitudes, beliefs and smart grid acceptance, suggesting that relationships among variables can be explored, e.g. between region and smart meter acceptance. This same survey data set has been used for other analyses of citizen acceptance of energy [71].

The survey instrument included a series of questions focused on respondents' knowledge, acceptance, and attitude related to smart meters. The smart meter related survey questions were embedded in the middle of a larger set of survey questions regarding vehicle ownership, electricity usage and awareness of electricity generation technologies. Question ordering is important because, as noted by Zeller and Feldman [72], contrary to the notion that survey respondents have well established opinions on subject matter, people may respond in a manner which is steered by the questions—in other words, researchers should be cautious about "priming" participants. We do not believe that these preceding survey questions (or the overall survey context) were likely to bias responses to the smart grid related questions. Directly before the smart meter survey questions, respondents were asked to indicate their level of support for different sources of electricity generation (including wind, run-of-river hydro plant, coal etc.), which may have prompted some respondents to reflect more on electricity sources than they normally would. It is not clear if such a question would bias respondents to be more or less supportive of smart meters. We focused the survey questions on smart meters because smart grid is a broad and novel concept for which public knowledge is limited [73]. However, as noted in Section 2, British Columbia and Ontario had recently deployed (or were in the process of deploying) smart meters on a large-scale and thus respondents in these regions were much more likely to have had previous exposure to this particular technology.

The smart meter section of the survey consisted of six closed-ended questions (Appendix B). The first three questions asked if participants knew of smart meters and whether they knew if their utility required their installation. The fourth question assessed overall support for mandatory smart meters by providing the statement "I support the mandatory installation of smart meters", where responses were elicited using a five-point "strongly agree" to "strongly disagree" Likert-type scale. The fifth question was a set of six statements exploring respondent attitudes toward smart meters, again using a five-point "strongly agree" to "strongly disagree" Likert-type scale for respondents (Fig. 1). These statements did not address the full spectrum of benefit and risk categories in the SPEED framework due to space constraints. Instead we focused on statements that were representative of the smart meter risks and benefits commonly mentioned in British Columbia, as we noted in our media analysis and stakeholder interviews (summarized in subsequent sections). Four statements addressed four types of risks: environmental, economic,

cultural and health and safety. Two statements addressed two types of benefits: electricity conservation (both environmental and economic) and grid management (technological).

The last survey question sought to explore the potential role of framing in citizen acceptance of smart meters, where we compare stated support using two different frames through a simple quasi-experiment. The first frame is that stated above (question 4), where the respondent is asked if they support mandatory smart meter deployment, where the survey does not describe any particular benefits. This first frame is similar to the framing of the initial smart meter deployment in British Columbia in 2010 (the Smart Meter Program)—mandatory, with no explicit explanations (framing) of benefits to the public. The last survey question provides a second frame, where smart meter deployment is described as being for the primary purpose of reducing “the environmental impacts of electricity use… to improve efficiency…and to increase the use of electricity made from wind, solar and run-of-river hydroelectricity” (full quote provided in Fig. 2). This second frame is explicitly pro-environmental, while also suggesting little economic risk (“installation of this smart meter will not cost you any money”), and not referring to mandatory installation. Following this description, respondents were asked to indicate their support for smart meters using a similar format as question 4. Comparison of responses to the two questions indicates how different framing of smart meter deployment (as one potential indicator of more general smart grid deployment) might impact citizen acceptance. However, we note that this method is not a true experiment (i.e. there is no random assignment of respondents, and no control group), so we must interpret results with caution. Further, we are not able to isolate the effects of pro-environmental framing because the second frame also described implications for installation costs (which would not be borne by customers) and did not describe the hypothetical program as mandatory.

In addition to depicting frequencies of survey responses for each region, we also use chi-square tests of association to statistically compare responses between regional sub-samples, and to compare levels of support and opposition for our two different framing (frame #1 and #2) of smart meters within each region.

3.2. Survey results

Overall, British Columbia respondents are substantially more negative about smart meter technology than respondents from other regions, for all questions asked (Fig. 1). Less than one-third of British Columbia respondents supported “mandatory installation of smart meters” (29%), where support was much higher among respondents from Ontario (46%) and to a lesser extent Alberta (32%) at the time of the survey in 2013. For all attitudinal questions, British Columbia respondents were more likely to state negative attitudes and less likely to state positive attitudes toward smart meters relative to respondents from Alberta and Ontario. For example, British Columbia respondents were more likely to believe that smart meters would “harm human health” (25% of respondents) versus Alberta or Ontario respondents (11% and 16% of respondents, respectively). Some patterns are consistent across all three provinces. For example, respondents in all regions were more likely to be concerned with economic and privacy issues associated with smart meter installation (between 30 and 40% respectively) than with the potential to harm human health (from 10% to 25%). All of the between-region differences observed in respondent attitude toward smart meters are statistically significant at a 99% confidence level (Fig. 1).

Fig. 2 compares respondent support of smart meters with the two provided frames. In the first frame (mandatory installation, no benefits stated), British Columbia respondents exhibited the lowest acceptance (29%) and the highest opposition (38%) of smart meters. Ontario respondents exhibited the highest acceptance (46%), and second highest opposition (22%) of smart meters. Finally, Alberta respondents had the second highest acceptance (32%) and the lowest opposition (14%) of smart meters. With the pro-environmental framing of smart meters (without installation costs, and not necessarily mandatory), respondent support significantly increased in every region (Fig. 2). British Columbia respondents show the largest decrease in opposition (decreasing from 37% to 19%), while their rate of support increased from 29% to 57%. The other two comparison regions showed similarly substantial increases in support (increasing by about 50–100%). The observed change in support in each region suggests that a more positive framing of smart meters (pro-environmental benefits, coupled with no installation costs), can positively impact citizen acceptance, even in a region such as British Columbia which displays comparatively strong negative perceptions of this technology. We cannot be certain how much of this increase in positive support can be attributed to pro-environmental framing (due to the lack of a true experimental design), but we suspect that it played an important role.

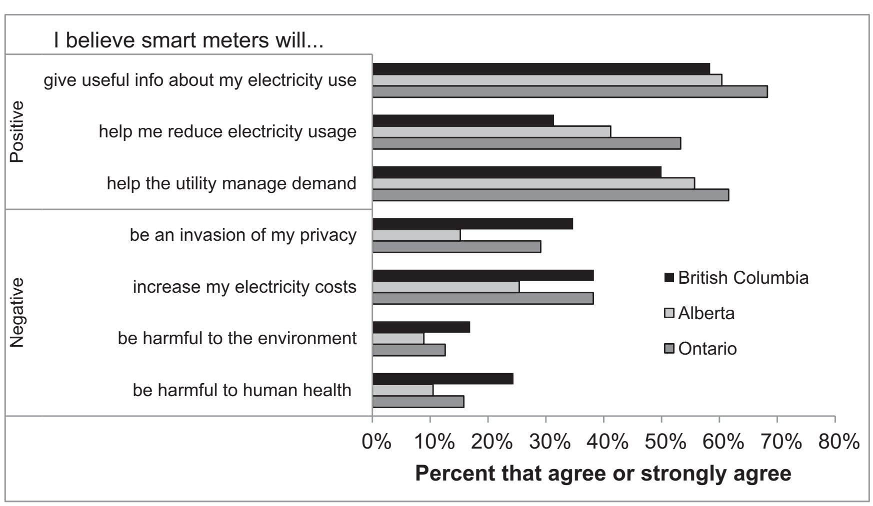

Fig. 1. Respondent attitude toward smart meters (British Columbia, n = 928; Alberta, n = 621; and Ontario, n = 1010. For all seven variables, the differences in stated acceptance across Provinces are statistically significant at a 99% confidence level, according to a chi-square test of association).

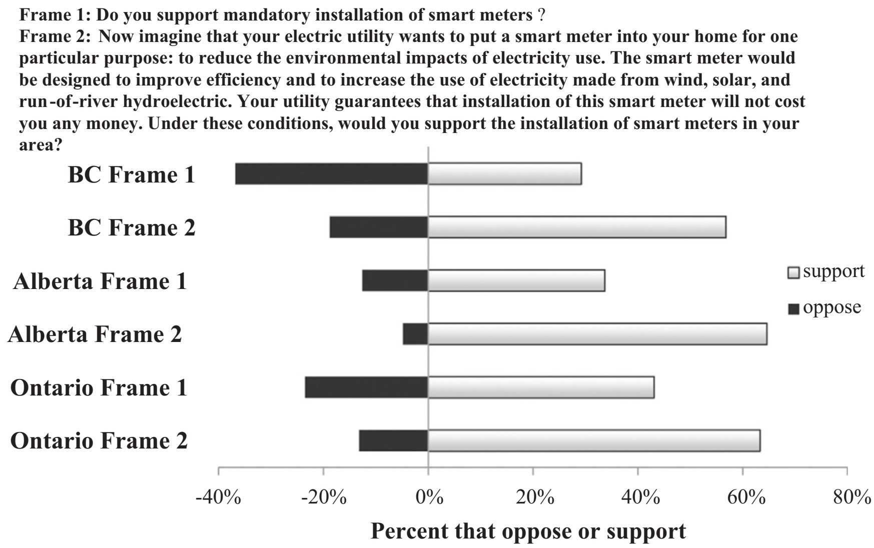

Fig. 2. Respondent support and opposition for two frames of smart meters (British Columbia, n = 928; Alberta, n = 621; and Ontario, n = 1010. Percentages do not add to 100% because there was an "I don't know" option. For each province, the differences between Frame 1 and Frame 2 acceptance are statistically significant at a 99% confidence level, according to a chi-square test of association).

4. Component #2: media analysis

4.1. Media analysis method

Our second method utilized media analysis of newspaper articles in British Columbia to assess media framing of smart meter deployment during the study period. Specifically, we characterize the risk and benefit frames associated with smart grid using the six SPEED categories to see how environmental framing is positioned within the overall societal discourse. Similar to work by Langheim et al. [30] and Mallett et al., [69] on smart grid media analysis, we searched for newspaper articles that included the terms "smart grid(s)", "smart meter(s)", or "smart electricity grid(s)" within *The Canadian Newsstand Database*. We limited our search to articles published between 1990 and 2012 within *The Vancouver Sun* and *The Province*, which are the two highest circulating newspapers in British Columbia, and identified a total of 225 articles. We trained two coders to analyze the media content using *NVivo 10* software.

To ensure consistency we conducted inter-coder reliability assessments in which the two coders each read and coded a randomly selected sample of articles equal to 20% of the population. Similar to Stephens et al. [33], if the coding from the total sample of double coded articles was less than 80% in agreement then further coder training was provided. Once intercoder reliability was achieved, we coded articles according to the specific technological components of smart grid, which included time-of-use pricing, distribution assets (e.g. remote sensors on transformers), electricity generation sources, electric vehicles, consumer appliances, smart meters, as well as smart grid overall. We then coded the articles according to how the media portrayed the risks and benefits of smart grid deployment in terms of the six SPEED frames: technological, economic, political, cultural, health and safety, and environmental [30]. Within these articles, each sentence could include more than one frame (e.g., political risk and cultural benefit), and each frame was coded a maximum of once per sentence (e.g., cultural benefit could not be coded twice in one sentence). We did not perform statistical analyses on media analysis results because we analyzed the full population of articles, rather than a sample (thus, there is no sampling error).

4.2. Media analysis results

In the British Columbia newspapers assessed, smart grid articles first occurred in 2007, grew in prevalence until 2011, and decreased overall in 2012 (Fig. 3). The initial smart grid articles in 2007 were triggered by a proposal from British Columbia's provincial government to install smart meters. The 2010 increase in smart grid articles coincided with the implementation of British Columbia's Smart Meter Program, mandated as part of the 2010 Clean Energy Act. Smart meters were mentioned in 93% of the 225 articles, which is far more frequently than all other smart grid components combined (Fig. 4). The second most frequently mentioned term was "smart grid" in general (19%), followed by "time-of-use pricing" (10%). The overwhelming media focus on the smart meter component supports the assumption in our survey method (Section 3) that British Columbia citizens are much more likely to have had experience with or exposure to smart meters than any other smart grid technology. Also note that media coverage rarely covered components more directly related to pro-environmental goals such as the electrification of transportation (e.g., electric vehicles), or electricity conservation (e.g., time-of-use pricing).

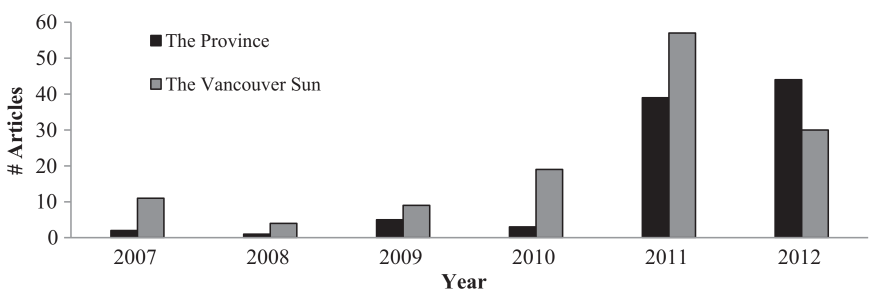

Fig. 3. The number of British Columbia newspaper articles relating to smart grid from 2007 to 2012.

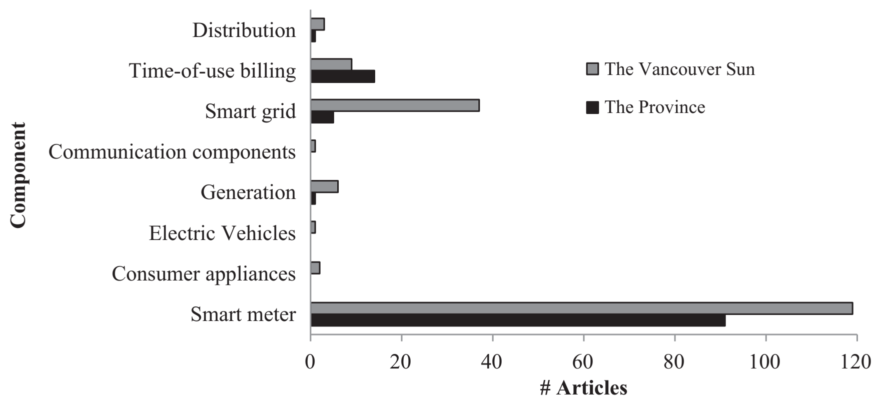

Fig. 4. Smart grid components mentioned in British Columbia newspaper articles (2007 to 2012).

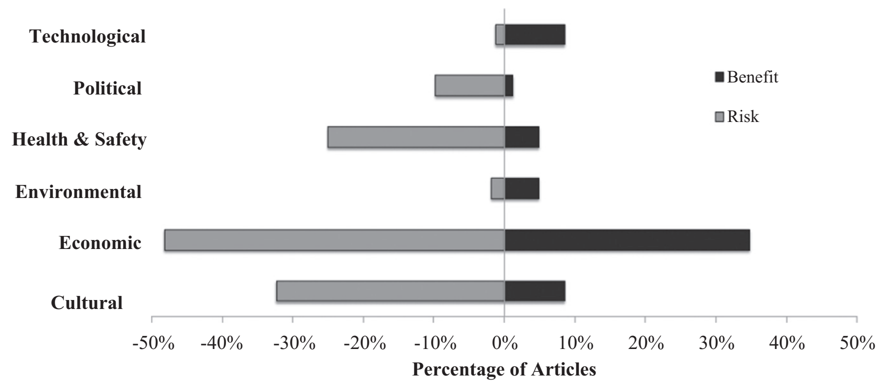

Fig. 5. SPEED risk and benefit frames mentioned in British Columbia newspaper articles (2007 to 2012).

In terms of our analysis of media frames, environmental frames were almost nonexistent in news media (Fig. 5). Only five percent of all articles mentioned environmental benefits, whereas 48% of articles mentioned economic risks and 35% mentioned economic benefits. Only a few of the articles discussing environmental benefits made direct reference to climate change mitigation. The other articles mentioning environmental benefits referred generally to "sustainable development," or reducing waste. Further, none of these newspaper articles directly linked renewable energy sources and smart grid deployment.

Consistent with citizen survey results, British Columbia newspapers' framing of smart grid risks and benefits tended towards the negative (Fig. 5). Economic risks were the most prominent frame in British Columbia newspapers (mentioned in 47% of articles) followed by economic benefits (35%), cultural risks (32%), and then health and safety risks (25%). Overall, smart grid risks were mentioned 1.9 times more frequently than smart grid benefits. Table 2 depicts frequencies of the top frames corresponding with four most relevant SPEED categories. The most frequently mentioned issue within the economic risk category was the cost of British Columbia's Smart Meter Program. The most frequently mentioned issue within the economic benefit category was the potential for smart grid to reduce electricity theft. In short, we see that British Columbia newspaper articles rarely mentioned the environmental benefits of smart grid—the discourse instead focused almost exclusively on smart meters, emphasizing smart meter economic risks and benefits as well as citizen opposition due to cultural and health and safety risks.

Table 2
Prevalent issues mentioned by British Columbia newspaper articles, categorized within the top SPEED categories (2007 to 2012).

Top categories	Most prevalent issue	% of mentions (within each category)
Economic risk	Cost of smart meter program	55%
	Inaccurate billing	27%
	Time-of-use pricing	16%
Economic benefit	Positively impact rate payers	34%
	Increasing cost effectiveness	30%
	Reducing electricity theft	24%
Cultural risk	General privacy issues	49%
	Hacking/cyber attacks	10%
	No opt out program	15%
Health and safety risk	Radio Frequency radiation	70%
	Fire Hazards	23%

5. Component #3: stakeholder interviews

5.1. Stakeholder interview methodology

Between October 2013 and February 2014, one author performed one-on-one semi-structured interviews with representatives from five key organizations that are influential proponents of smart grid deployment in British Columbia. The stakeholders interviewed are only a subset of possible stakeholders and were chosen due to their ability to influence smart grid policy decisions and public perception. The stakeholders interviewed are associated with the following organizations:

1. The British Columbia Government, which as of the study period were the same political party that originally legislated smart grid deployment in 2010;

2. British Columbia (BC) Hydro, the primary electric utility (serving about 90% of British Columbia households) that was responsible for implementing the Smart Meter Program in 2010–2014;
3. Powertech, a British Columbia Hydro subsidiary that conducts research and development relating to energy technology;
4. The British Columbia Sustainable Energy Association, a non-profit group that actively promotes the sustainable use of energy in British Columbia;
5. Sgurr Energy, a private sector renewable energy consultancy that as of 2014 was working with British Columbia Institute of Technology on a decentralized smart grid project.

In interviews the stakeholders were asked to provide their individual perspectives on the risks and benefits of smart grid in British Columbia; therefore the results are not necessarily reflective of their associated organization (See Appendix C for questionnaire). Each of these stakeholders is associated with an organization that supports smart grid deployment, and these interview results would differ if smart meter opposition groups were included (e.g. Citizens for Safe Technology). Thus our interview results do not provide a representation of all stakeholders in British Columbia. Rather, these interviews help to illustrate how five pivotal smart grid actors perceive and frame smart grid. Insights from BC Hydro and the British Columbia Government participants are particularly relevant because these organizations will likely be in charge of creating and implementing future smart grid programs, just as they were with the Smart Meter Program.

After transcribing the interviews we used *NVivo 10* software, a text analysis tool, to organize and analyze interview content according to: (1) stated smart grid benefits, (2) stated smart grid risks, and (3) stated connections between smart grid and climate change mitigation. We used SPEED categories to help guide our coding of stated smart grid risks and benefits. As with the media analysis, each of these categories were coded a maximum of once per sentence. While imperfect, our analysis used the frequency with which a stakeholder mentioned a motivation or risk as a proxy for indicating the significance of this risk or benefit to the stakeholder. Further, we realize that with our small sample size (n=5) the frequency of mention does not provide a reliable metric to measure the societal framing of smart grid risks and benefits. However, in combining these metrics with our other methods to assess socio-political acceptance, we believe that our analysis can generally convey how these pivotal smart grid stakeholders perceive and frame smart grid deployment in BC. Other studies on energy also use frequency of mentions from a small sample of key stakeholders as an indicator to help determine importance [74,75].

5.2. Stakeholder interview results

Table 3 presents the most frequently mentioned benefits and risks for each participant. In terms of benefits, all participants focus most on how smart grid can help reduce costs of the electricity grid. When discussing cost reduction, each participant came from a unique perspective. For instance, the BC Hydro participant spoke about smart grid technologies “bringing about benefits related to the [financial] bottom line for operating the company”, whereas the BC Government participant indicated that smart grid may reduce, or at least slow the growth of, overall electricity prices. The two major cost reduction pathways mentioned by participants are the potential for smart grid to reduce electricity losses by allowing utilities to pinpoint and eliminate electricity theft, and for smart grid to more efficiently utilize existing infrastructure and thus increase the capacity of electricity that is currently available. “Integrating renewables” was the second most frequently mentioned benefit overall, and was the most frequently mentioned benefit for the British Columbia Government (eight mentions). This benefit was commonly described by participants as the integration of intermittent renewables such as wind and solar through more efficient management of electricity supply and demand. The “integrating renewables” benefit they described could align with an environmental benefit frame, or with a technological benefit (efficiency) frame, depending on if the participant believed that further deployment of intermittent renewable energy sources would lead to a net reduction in greenhouse gas emissions.

Table 3 also summarizes the top two risks mentioned by each participant. The most frequently mentioned risks related to: the potential for smart grid deployment to increase electricity costs (Economic risk), investing in technology that too quickly becomes obsolete (Technological risk), and public opposition stemming from health and privacy concerns (Cultural risk). Interestingly, while the citizen survey and media analysis revealed high levels of concern about smart meter human health and privacy risks, participating stakeholders only mentioned these risks in reference to how such public perceptions will decrease public acceptance. Of the five interviewees, no participant suggested that smart grid development posed actual risk to human health or privacy.

Table 4 illustrates how many times each benefit was mentioned overall (across all five interviews), and provides an example quote. Economic benefits were by far the most frequently mentioned across participants, particularly in terms of cost reductions and strengthened grid reliability. Several of the other stated benefit frames relate to the environment, including integrating renewable energy sources, facilitating demand side management, supporting the electrification of transportation, and complying with British Columbia's 2010 Clean Energy Act requirements.

As a final analysis, in Table 5 we provide examples of how each participant linked smart grid deployment to climate change mitigation in British Columbia. Whereas previous interview questions were openly stated, Table 5 presents responses to a specific question we posed: “do you see smart grid contributing to climate change mitigation?” We asked this question directly because British Columbia's deployment of smart meters was part of the 2010 Clean Energy Act, which targets greenhouse gas mitigation. Further, as noted in our introduction, when key stakeholders prioritize climate change mitigation smart grid is more likely to develop in a manner that reduces GHG emissions climate change. Although economic benefits seem to be the highest priority for each interviewed stakeholder (a theme echoed in our survey and media analysis results), Table 5 indicates that all participants can link smart grid deployment to the reduction of GHG emissions. Again, commonly mentioned mechanisms were renewable integration, electrification of transportation and/or electricity conservation. However, there is uncertainty in some cases—in particular, the Sgurr and BC Hydro participants stated that smart grid will not be able to significantly abate GHGs in British Columbia because the grid is already of low carbon intensity. In contrast to this view, the Powertech participant indicated that smart grid can greatly reduce British Columbia's GHG emissions by facilitating the deployment and recharging of electric vehicles if and when relevant smart grid technologies reach

Table 3
Most frequently mentioned risks and benefits by key stakeholders (with number of mentions in parenthesis).

Stakeholder organization	Most frequently mentioned benefit	Most frequently mentioned risk
British Columbia Government	Integrate renewables (8), and reduce cost (6)	Increase cost (9) and public opposition (9)
BC Hydro	Reduce costs (12), and demand side management (2)	Public opposition (9) and obsolete technology (9)
Powertech	Reduce costs (9), and integrate renewables (2)	Increase cost (4) and obsolete technology (4)
British Columbia Sustainable Energy Association	Reduce costs (7), and integrate renewables (2)	Increase cost (10), and public opposition (10)
Sgurr Energy	Reduce costs (5), and demand side management (2)	Increase cost (10), and public opposition (5)

Table 4
Examples of stakeholder perceptions of smart grid benefits in order of frequency of mentions (all interviews).

Benefits	Frame	Number of mentions	Example
Reduce cost	Economic	38	*"In the long term, there will be cost savings by adopting smart grid technologies as opposed to leaving the system as it is"* British Columbia Government participant
Integrate renewables	Environment, technical	19	*"Distribution grids need to be able to respond quickly to integration of solar panels and other alternative energy sources"* British Columbia Government participant
Strengthen reliability	Technical, Economic	8	*"If you have better information about your assets, you can enhance the reliability of your assets"* British Columbia Hydro participant
Demand side management	Technical, Economic	8	*"One day there will be time-of-use rates in British Columbia… it's price elasticity right? You've got to make it a little punitive"* Powertech participant
Integrate electric vehicles	Environment, Technical	7	*"EVs are a tremendous threat and opportunity to a utility. If we allow everybody to drive those things home an plug them in when they get home from work, all hell's gonna break loose"* Powertech participant

large-scale commercialization, e.g. those technologies supporting vehicle-to-grid integration.

6. Discussion

6.1. Integrating multi-method insights from the British Columbia case study

Our multi-method study explores the role of framing in socio-political acceptance of smart grid technologies, using the case of British Columbia. One central motivation for this research question is that smart grid technologies can be planned and deployed to meet multiple objectives, notably those relating to economics savings, improved grid reliability and greenhouse gas (GHG) mitigation. While these goals can sometimes be complementary, in some scenarios a primary focus on one objective (e.g. cost minimization) might conflict with another objective (e.g. GHG mitigation) [3], so the prioritization of these goals may be important. Given that smart grid deployment was required as a part of British Columbia's 2010 Clean Energy Act, one might assume that the environmental benefit frame would play a strong role in social discourse. However, the extensive public opposition to smart meter deployment from 2010 to 2014 suggest that other frames were influential, such as human health and privacy risks. We next summarize insights from three different components of socio-political acceptance—citizen acceptance, media and stakeholders—and then integrate these insights to provide recommendations for future smart grid deployment.

First, our survey of citizen perceptions in 2013 indicates that respondents in British Columbia have a particularly negative view of smart meters (as the smart grid technology of focus) when compared to Ontario, a region that has also deployed smart meters and Alberta, a region that has not deployed smart meters at a large scale. British Columbia respondents were particularly concerned about invasion of privacy and potential health effects. Despite this initial negativity, our survey results suggest that reframing of smart meter deployment could substantially boost citizen acceptance among British Columbia respondents, as well as in the other two regions in Canada. Specifically, compared to a fairly neutral description of mandatory smart meter deployment (no frame) respondent support nearly doubled when smart meters were described as part of a pro-environmental strategy; where installation costs would not be borne by users. The substantial impact of this positive reframing in our study is supported by research by Toft et al. [57], who demonstrated that a mixture of private and collective benefits motivates the acceptance of smart grid technology in Denmark, Norway and Switzerland.

Consistent with our citizen survey, our media analysis finds that British Columbia media tends to be negative about smart grid technology. This negativity has also been found in the Quebec media [3]. In contrast, media analyses conducted between 2012 and 2013 examining national-level newspapers in other Canadian areas (e.g. Ontario) and the US found that smart grid coverage tended to be much more positive [30,69]. Although it is not possible to determine cause and effect between media coverage and citizen perceptions, we can say that the negativity expressed by British Columbia survey respondents aligns with the negative media coverage in the region (when compared to some other regions in Canada). In terms of media framing, we find that economic benefit and risk frames dominated the discourse, while only five percent of smart grid articles mention the environmental benefits of smart grid. Of the five percent of articles that use an environmental frame, only three articles directly reference the potential for GHG reductions. The lack of environmental framing in British Columbia media is in contrast to an American smart grid media analysis that found over 20% of articles mentioned environmental benefits [30], suggesting that media framing can substantially vary across regions. Further, the apparent lack of environmental framing in British Columbia is surprising given that smart meters (the only smart grid initiative deployed to date) were ostensibly deployed as part of a climate mitigation strategy.

Our third method draws insights from several of the most relevant smart grid stakeholders in the region. When discussing the potential benefits of smart grid deployment, four of the five participants

Table 5
Linkage between smart grid and climate change mitigation (when asked directly by interviewer).

Stakeholder	Example of a quote about climate change mitigation in British Columbia
British Columbia Government	*"If, for example, there can be renewable electricity that is more local… and the smart grid is enabling this to happen, yeah, then I think it would contribute to [climate change mitigation]."*
British Columbia Hydro	*"With wind farms, one important smart grid component is storage. We don't have that [intermittency] problem here, but certainly [smart grid] can be used in places where they have a lot of alternative energy sources that can replace traditional generation."*
Powertech	*"The smart grid will enable electric vehicle adoption…If you drive an electric vehicle in British Columbia it's around 5 t of carbon reduced per car, per year …over [a conventional] vehicle."*
British Columbia Sustainable Energy Association	*"Information smart meters provide can help with [energy conservation]. People who design and build products to aid energy efficiency or demand response need access to data, and the more they have, the better they can tune their products to serve society."*
Sgurr Energy	*"If we say smart grid facilitates sticking a wind farm on the old grid, then that's a smart grid investment and yes, it's going to reduce emissions to the extent that wind replaces fossils, which again in British Columbia, maybe not."*

mentioned economic benefits (namely reducing costs) more frequently then environmental benefits, and two explicitly mentioned that there is little need for smart grid to abate GHG emissions in British Columbia because its electricity system is already low-emission. Such stakeholder prioritization of benefits can be important; studies from the US and the Canadian province of Quebec suggest that if smart grid is not being actively framed as a way to mitigate climate change, smart grid investment is more likely to focus on optimizing the costs and reliability of the current infrastructure, resulting in little to no reductions in GHG emissions [3,76].

6.2. Broader implications for framing and socio-political acceptance of smart grid

This multi-method study demonstrates the potential value of exploring all three components of socio-political acceptance–citizens, media and stakeholders–as such an approach allows the researcher to identify important relationships and contrasts among these components. Further, the SPEED framework proved useful in helping to identify and compare frames across these components. While this framework was intended for application to policy analysis, media analysis and stakeholder interviews [33], our application to a citizen survey is novel but also useful—in particular in the revealed similarities between media coverage and citizen perceptions, and in the contrasts between citizen and stakeholder perceptions. Our insights reinforce previous research findings on the importance of framing in citizen perceptions and societal decision-making [14,36,56,59]. Taken together, our approach provides a comprehensive perspective that can help policymakers and stakeholders to better understand the role of framing in citizens' support for, or opposition to, different aspects of smart grid deployment.

While we investigate only one case study, several insights may be generalizable, or at least worth testing as hypotheses on other case studies. First, active, positive framing of smart grid deployment can possibly boost citizen acceptance. Pro-environmental framing could be particularly effective, though our current study cannot isolate the effect due to a quasi-experimental design. But our study does produce evidence that if smart meter deployment is positioned as part of a climate mitigation strategy, without installation costs and with a clear opt-out program, then citizen support could increase substantially, even in a region with initially high levels of smart meter opposition (i.e. British Columbia). This finding supports the hypothesis posed by European researchers that citizen acceptance of smart grid will be higher if societal discourse emphasizes both economic and environmental benefits of smart grid [77], which has also been suggested in several other studies of smart grid acceptance [21,30]. Potentially, such pro-societal framing can more closely align with citizens' core values [57]. In this vein, it is important to be cognizant of context, where frames that are deemed to be locally relevant can resonate more effectively with the public [56].

Further, smart grid proponents can potentially avoid or mitigate conflicts through early and genuine engagement with citizens and other stakeholder groups. Our case study identified a large disconnect between the attitudes and perceptions of citizens as compared to key stakeholders. Both media coverage and initial citizen perceptions of smart meters were highly negative, while key stakeholders tended to be much more optimistic about smart grid deployment, including the potential economic and technical benefits. Stakeholders only rarely mentioned the health and privacy concerns observed in media and among citizens, and when doing so they tended to dismiss the importance of such perceptions. Research suggests that public engagement can help stakeholders to identify potential concerns early on, while providing opportunities to identify solutions that might be acceptable to citizens and stakeholders [17]. Such engagement can also bolster citizen support for energy projects if the engagement leads to an increase in perceived trust in the project proponent [20].

To successfully move forward with smart grid deployment as a tool for GHG abatement it seems important for a region to have a clear overarching vision that embeds smart grid deployment into climate goals [78]. Regions that already have GHG goals or legislation could potentially improve socio-political acceptance by more clearly connecting smart grid deployment with these climate change goals, i.e. to increase renewable energy deployment, energy conservation, and electrification of fossil fuel-based technologies (e.g. transitioning from internal combustion engines to electric vehicles). For example, the British Columbia government and electric utility (BC Hydro) might have gained more citizen acceptance for smart meters if their deployment had been clearly framed as a GHG abatement action, using the Province's Clean Energy Act. Because key stakeholders can use frames or storylines to shape the overall trajectory of state energy policy [47–49], it would seem advantageous to reinforce the environmental or climate abatement frame if those climate goals are genuine.

7. Conclusion

We explore the role of framing in socio-political acceptance of smart grid technologies, using a multi-method approach in the case of British Columbia, Canada. We focus on the environmental frame because the deployment of various smart grid technologies may play an important role in GHG abatement, in particular by facilitating the electrification of current fossil fuel based sectors, the deployment of renewable energy, conserving electricity, and in providing an example for other jurisdictions to follow (for instance, electrification of vehicle fleets using a low carbon emission source of electricity). While the technical and socio-political context of British Columbia is unique in many ways, it is similar to other regions globally in that smart grid deployment is likely necessary to facilitate the numerous bold actions and policies that will be required to achieve deep greenhouse gas reduction targets by 2050 (e.g. 80% reductions compared to 2007 levels). We find that the pro-environmental frame is largely missing from socio-political discourse (citizens, media and key stakeholders), while inclusion of this and other positive, constructive frames could be important to building socio-political acceptance, as has been found by others [14,57]. A clearly communicated vision of how smart grid can contribute to climate change mitigation could serve to increase citizen acceptance in our case region and also likely in other regions given our consistent finding across three different Canadian provinces with very different electrical grids and energy economies. To help avoid opposition and negative perceptions, smart grid proponents could more effectively engage the public to help build trust and allow decision makers to learn about how positive framing my impact socio-political acceptance. Such efforts can allow decision makers and the public to learn from collaboration and design citizen-informed energy plans that experience less socio-political opposition.

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Appendix A. Sample demographic characteristics compared to census data

	Survey CAN	*Census CAN*	*Survey BC*	*Census BC*	*Survey AB*	*Census AB*	*Survey Ont*	*Census Ont*
Gender								
Female	55.6%	51.0%	58.6%	51.0%	62.8%	49.8%	54.5%	51.2%
Age								
< 35	32.7%	31.2%	34.4%	30.1%	32.9%	35.8%	33.5%	31.2%
35–54	38.7%	35.2%	36.0%	34.9%	38.4%	36.4%	41.4%	35.9%
> 55	28.5%	33.5%	29.7%	35.0%	28.7%	27.7%	24.9%	32.9%
Education								
College or trade	31.7%	28.2%	29.5%	27.6%	34.7%	28.9%	31.4%	33.1%
Bachelor's	24.1%	*13.5%*	*24.6%*	*14.2%*	*21.5%*	*13.5%*	*26.3%*	*31.5%*
Graduate	10.5%	*4.6%*	*9.8%*	*5.1%*	*7.5%*	*4.0%*	*13.0%*	*5.5%*
Income								
< $70k	45.7%	53.2%	49.0%	53.6%	40.4%	44.7%	39.3%	45.3%
$70–99k	27.8%	21.4%	27.6%	21.5%	26.6%	22.2%	26.5%	25.2%
> $100k	24.1%	25.5%	26.5%	24.9%	23.3%	33.1%	25.5%	29.5%
Household								
1 person	13.1%	*27.6%*	*14.6%*	*28.3%*	*14.2%*	*24.7%*	*10.6%*	*25.2%*
2 people	40.0%	*34.1%*	*39.1%*	*34.8%*	*40.6%*	*34.3%*	*35.3%*	*32.4%*
3 or more	49.2%	38.3%	46.3%	37.0%	48.7%	41.1%	54.1%	42.4%

Appendix B. Smart meter survey questions

1. Prior to taking this survey, had you heard of smart meters? **(Response: yes/no/I don't know)**
2. Do you have a smart meter installed at your home? **(Response: yes/no/I don't know)**
3. Does your electric utility require that you have a smart meter installed? **(Response: yes/no/I don't know)**
4. To what extent do you agree or disagree with the following statements about smart meters? **(Response: 5-point Likert-type scale ranging from strongly disagree to strongly agree and I don't know)**

- I support the mandatory installation of smart meters.
- Smart meters…
  1. …will help the utility manage electricity demand.
  2. …will help me reduce my electricity usage.
  3. …will be harmful to human health (e.g. electromagnetic radiation).
  4. …will be harmful to the environment.
  5. …will give useful information about my electricity use.
  6. …will increase my electricity costs
  7. …will be an invasion of my privacy

Question 5 provided background information before eliciting a response:

"Now imagine that your electric utility wants to put a smart meter into your home for one particular purpose: to reduce the environmental impacts of electricity use. The smart meter would be designed to improve efficiency and to increase the use of electricity made from wind, solar, and run-of-river hydroelectric. Your utility guarantees that installation of this smart meter will not cost you any money."

5. Under these conditions, would you support the installation of smart meters in your area? **(Response: 5-point Likert-type scale ranging from strongly support to strongly oppose)**

Appendix C. Stakeholder interview questionnaire

1. ***What is "smart grid"?***
2. ***Is British Columbia's electricity grid currently "smart"?***
3. ***What smart grid components does British Columbia have currently?***
4. ***What smart grid components are in the planning stage?***
5. ***What is the rationale for smart grid?***
6. ***What are some benefits or opportunities associated with smart grid?***
7. ***What are some risks or challenges associated with smart grid?***

8. ***Who are the most important stakeholders associated with smart grid in British Columbia?***
9. ***How is energy policy influencing smart grid in British Columbia?***
10. ***How important is public support for smart grid in British Columbia?***
11. ***What contributions do you think smart grid can offer to sustainable development?***
12. ***Do you see smart grid contributing to climate change mitigation?***

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